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AGRICULTURAL MEMORANDUM NO 731

# FROST FREQUENCY IN SPRING AT LUDDINGTON EHS, WITH GENERAL COMMENTS ON THE PRESENTATION OF FROST SURVEYS.

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## INTRODUCTION

Night minimum temperatures recorded at Luddington Experimental Horticultural Station (near Stratford-on-Avon) between 1 April and 27 May over the last 24 years (1951-1974) were examined in connection with a Frost Survey now in progress.

The experimental grounds at Luddington cover 93 hectares (230 acres) and lie on a south-facing slope down to the River Avon. The present meteorological observing site is on the higher ground in the north-east corner at 56 metres above sea level. Prior to 1968 observations were made at a site about 350 metres west of the present one, but previous investigations have shown that the 2 sites have roughly the same frost liability. On the other hand, temperatures at the lowest part of the Station are known to fall 2-3°F lower on radiation nights. For this reason temperatures below 36°F at the observing site were included in the analyses.

## RESULTS

Table 1 shows the results obtained both by considering the number of occasions in a year when the temperature fell below a given level after starting dates chosen at weekly intervals from 1 April, and the number of years when at least one of these occasions was recorded. (Note that the temperatures as reported up to 1970 were in whole degrees Fahrenheit, so that strictly speaking the levels given represent 36.4° 34.4° and so on. 1971-1974 values were adjusted to conform.)

In Agric Memo No 533 J W Davies gave curves for Long Ashton of the frequencies (years in 10) of the extreme minimum temperature after a given date. Similar curves for Luddington were derived by smoothing the values given in Table 1 (D). These are shown in Figure 1 together with similar curves for Ross-on-Wye for comparison. The 2 sets of curves can be brought into quite close agreement by subtracting about 1.5°F from the Ross temperature levels.

The average values for Luddington in Table 1 do however conceal some important periodic variations, as shown in Figure 2. The extraordinarily high frequency of frosts at Luddington in the mid-1950s may be seen, though with little support from Ross-on-Wye and none from Edgbaston. Taking Ross-on-Wye and Luddington together however there is some indication of a cycle of about 15 years, though it is impossible to say whether this is real and likely to be repeated.

## PRESENTATION OF THE RESULTS OF FROST SURVEYS

In recent years it has been the custom to present the results of Frost Surveys in the form given in Table 1 (D), the assumption being that only one frost of the required severity after a given date is sufficient to damage or wipe out a crop. In general the chances of success in a 10-year period is a useful management input,

though a grower who contemplates protection by irrigation or heating will also need an estimate of how often or for how long his equipment will be in use.

Applying long-term averages without qualification to a given 10-year period can be dangerous, as a glance at Figure 2(a) reveals. Indeed from Table 1 we can see that up to 50 per cent errors can occur in the "years in 10" estimate, particularly at the lower temperatures in the mid-season period. It is particularly unfortunate that the effect of these errors is greatest at the point where decision-making is most critical.

The alternatives of presenting the results as "years in 20" or as percentage probabilities are no more helpful to the grower. The answer seems to lie in making it abundantly clear that even where a comparatively small number of high-risk years is shown (less than 4 out of 10 say) these may nevertheless (and quite likely will) occur in sequence, thus enabling the recipient to take into account the financial problems that might arise from successive crop losses.

Any comments or suggestions on this paper should be sent to the author.

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Table 1. LUDDINGTON 1951-1974. OCCASIONS OF MINIMUM TEMPERATURE EQUAL TO OR LESS THAN THE STATED VALUES, FROM THE DATES SHOWN UNTIL 26 MAY

A = Average number of occasions per year

B = Maximum number in any year

C = Minimum number in any year

D = Average number of years in 10 with at least one occasion

E = Highest number of years in any 10-year sequence with at least one occasion

F = Lowest number of years in any 10-year sequence with at least one occasion

STARTING DATE

| Min Temp °F | | Apr 1 | Apr 8 | Apr 15 | Apr 22 | Apr 29 | May 6 | May 13 | May 20 |
|---|---|---|---|---|---|---|---|---|---|
| ⩽ 36 | A | 14.2 | 11.1 | 8.5 | 6.1 | 4.1 | 2.4 | 1.4 | 0.5 |
| | B | 28 | 22 | 21 | 14 | 9 | 8 | 7 | 4 |
| | C | 4 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| | D | 10.0 | 10.0 | 10.0 | 10.0 | 9.6 | 6.7 | 5.4 | 2.5 |
| ⩽ 34 | A | 9.0 | 7.2 | 5.4 | 3.7 | 2.5 | 1.4 | 0.8 | 0.3 |
| | B | 21 | 18 | 17 | 10 | 7 | 5 | 5 | 3 |
| | C | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | D | 10.0 | 9.6 | 9.6 | 8.7 | 8.3 | 5.4 | 3.7 | 1.7 |
| ⩽ 32 | A | 6.3 | 4.7 | 3.5 | 2.3 | 1.4 | 0.7 | 0.4 | 0.1 |
| | B | 17 | 15 | 13 | 7 | 4 | 3 | 3 | 2 |
| | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | D | 9.2 | 9.2 | 8.7 | 7.9 | 6.7 | 4.6 | 2.5 | 0.8 |
| | E | 10 | 10 | 10 | 9 | 8 | 6 | 4 | 2 |
| | F | 9 | 9 | 8 | 7 | 6 | 3 | 2 | 1 |
| ⩽ 30 | A | 3.3 | 2.2 | 1.5 | 0.8 | 0.4 | 0.2 | 0.1 | 0.0* |
| | B | 11 | 9 | 8 | 4 | 2 | 2 | 2 | 1 |
| | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | D | 8.3 | 7.9 | 5.8 | 4.6 | 3.3 | 1.3 | 0.8 | 0.4 |
| | E | 9 | 9 | 7 | 6 | 6 | 3 | 2 | 1 |
| | F | 8 | 7 | 5 | 3 | 2 | 1 | 1 | 0 |
| ⩽ 28 | A | 1.6 | 1.0 | 0.7 | 0.4 | 0.3 | 0.1 | 0.0* | 0.0* |
| | B | 4 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| | C | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | D | 6.7 | 5.0 | 3.3 | 2.5 | 2.5 | 0.8 | 0.4 | 0.0 |
| | E | 8 | 7 | 5 | 5 | 5 | 2 | 1 | 0 |
| | F | 5 | 3 | 2 | 1 | 1 | 1 | 0 | 0 |

Note: * = < 0.05

FIGURE 1 FREQUENCIES OF EXTREME MINIMUM TEMPERATURES

AFTER A GIVEN DATE EXPRESSED AS YEARS IN 10.

WEEK 1 APR 1-7
3 APR 15-21
5 APR 29-MAY 5
7 MAY 13-19

WEEK 2 APR 8-14
4 APR 22-28
6 MAY 6-12
8 MAY 20-26

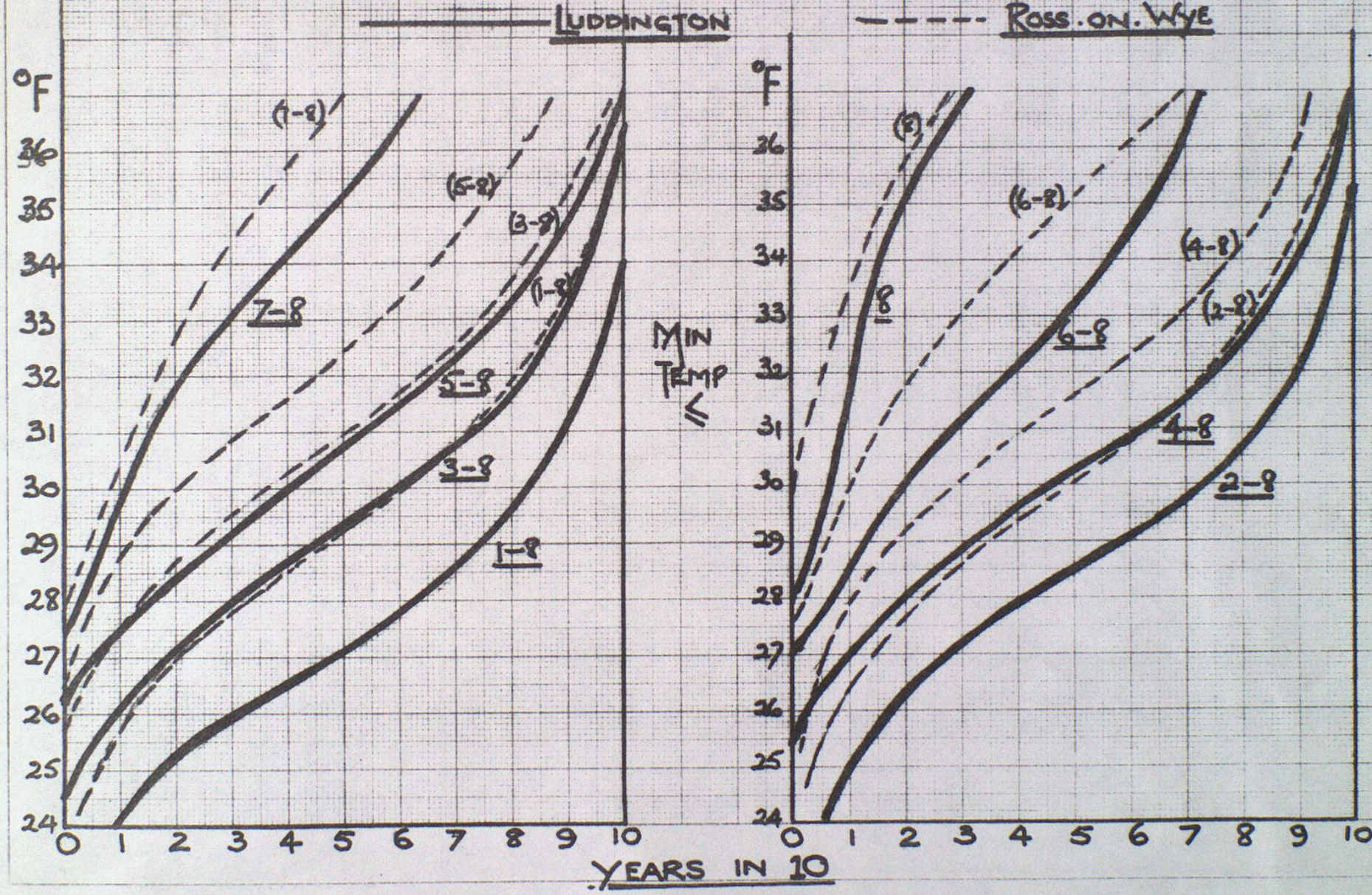
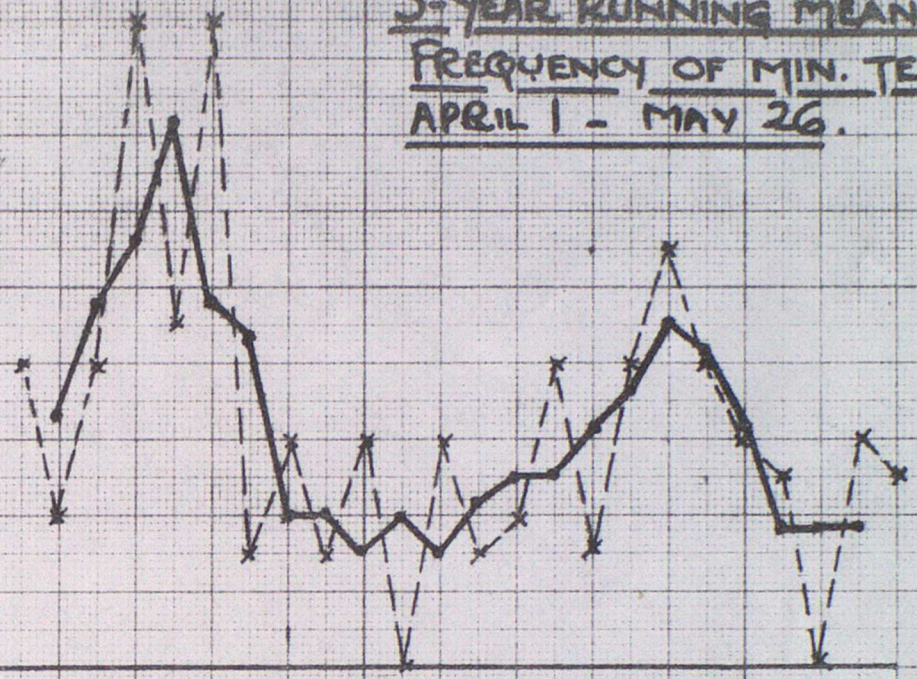


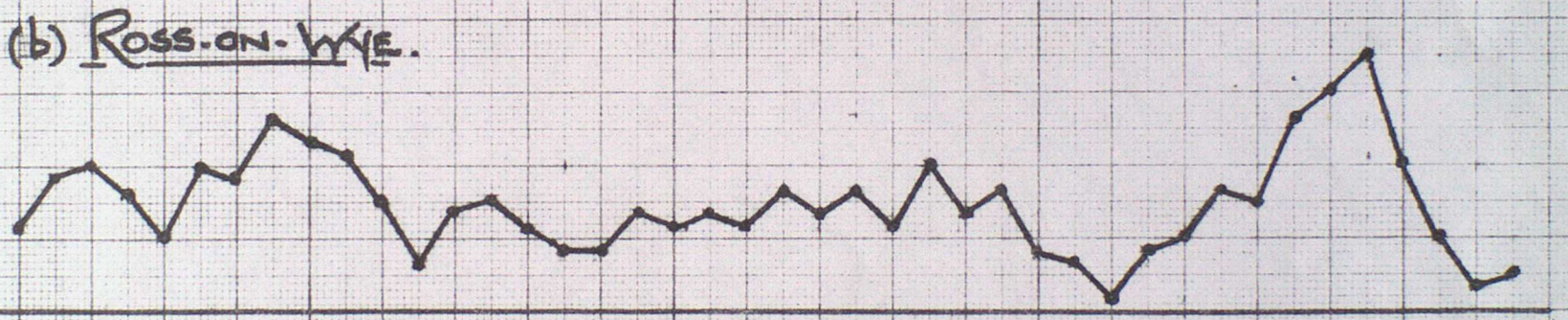
FIGURE 2.

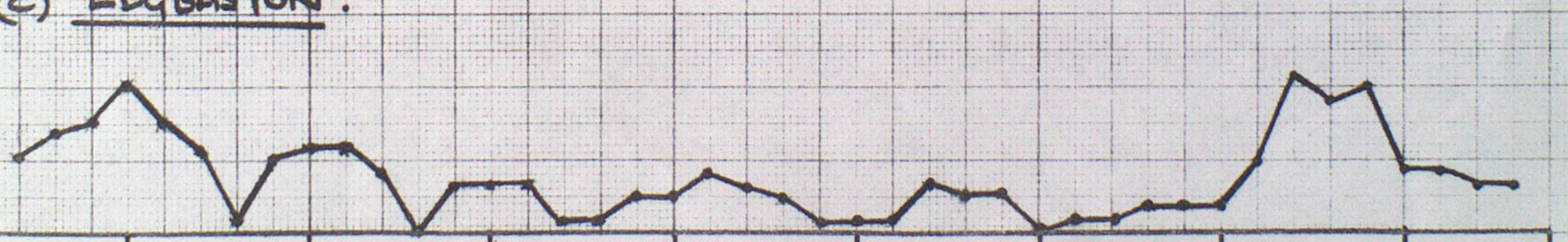
3-YEAR RUNNING MEANS OF FREQUENCY OF MIN. TEMP ≤ 32.4°F APRIL 1 - MAY 26.

(a) LUDDINGTON.

[WITH ANNUAL VALUES SHOWN THUS x - - - x]






OCCASIONS PER YEAR.

18 16 14 12 10 8 6 4 2 0

8 6 4 2 0

6 4 2 0

1930 1935 1940 1945 1950 1955 1960 1965 1970 1974

RW 9760 70 5/75 BL